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ABSTRACT BOOK

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Fresh diluted bitumen and a shoreline oil cleaner impair water striders under environmentally realistic conditions

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Keywords:
oil spill, invertebrates, corexit

Abstract:

Shoreline cleaners have been proposed as a tool to address oil spills from accidental pipeline breaches in boreal aquatic ecosystems. Littoral zones and the communities that reside in them can be particularly vulnerable from oil fouling and subsequent clean-up. Water strider (Family: Gerridae) communities rely on intact riparian environments for shelter and food and represent a case study for investigating possible impacts from shoreline cleaners. To investigate this, diluted bitumen volumes ranging from 0 µL/m^2 to 205 µL/m^2 were applied to land-based test tanks containing 20 striders each (*Metrobates sp.*) with and without COREXIT EC9580A, a hydrocarbon-based shoreline cleaner. Oil-only impacts were observed at volumes of 7.5 µL/m^2 and up, with greater than 50% immobility observed within 8 hours. Effects were greater when EC9580A was applied, with 100% immobility observed immediately upon application at 2.5 µL/m^2 of dilbit and up. Our work reveals a sensitivity to this mixture by surface-dwelling insects that warrants further investigation to inform Net Environmental Benefit Analyses (NEBAs). EC9580A and other shoreline cleaners should undergo more stringent regulation to limit impacts to freshwater organisms considering the greater impacts of the cleaner with oil relative to the independent effects of the oil.

Identifying target organs and candidate contaminants based on adverse outcomes following sub-chronic oral exposure in rats to contaminated soil extracts from a pesticide manufacturing site.

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Soil sample extracts from a legacy contaminated site were examined using an effects-directed approach. The study aimed to identify target organ toxicities after twice-weekly oral gavage of 3 different soil extracts (vehicle control and 0.1% of each extract in polyethylene glycol) in male Sprague Dawley rats (n=10/group). After 28 days, a significant increase in blood inflammatory marker was seen in rats exposed to all 3 extracts. A significant reduction in plasma cholinesterase activity was observed. A significant increase in hepatic ethoxyresorufin-o-deethylase activity was also observed after exposure to extracts A and B. Oxidative stress was detected in the brain and kidney tissues after exposure to extracts B and C, respectively. Acute tubular necrosis was seen in rats exposed to the extracts. Candidate causative agents include organochlorine, organophosphate/carbamate insecticides. Kidney damage and systemic inflammation are clear targets, but some risk may arise from brain oxidative stress.

Keywords: Contaminated soil, toxicity, rats

Characterizing the impacts of diluted bitumen spill remediation methods on freshwater benthic macroinvertebrates using shoreline enclosures

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Key words: Diluted Bitumen; Oil Spill Remediation; Benthic Invertebrates; Limnocorrals

There is significant uncertainty regarding the impacts of current and proposed oil remediation methods for freshwater ecosystems following spill events. To address some of these gaps, the Freshwater Oil Spill Remediation Study (FOReSt) was conducted in a boreal lake at the IISD-Experimental Lakes Area in summer 2019 (Ontario, Canada). The primary focus included two remediation approaches: Enhanced Monitored Natural Recovery (EMNR) and a Shoreline Cleaning Agent (SCA; Corexit EC9580A). A total of 16 five by ten-metre shoreline enclosures were installed into two substrate types: peat organic or rock-cobble. There were eight enclosures per substrate with a triplicate of each treatment, in addition to two reference enclosures. Treated enclosures underwent a simulated oil spill and industry standard clean-up response scenario, prior to application of experimental remediation treatments. The benthic invertebrate community was monitored before and after oil spill and subsequent treatment. Total abundance of benthic invertebrates was significantly different between substrates ($p = 0.01$) and between treatments ($p = 0.03$). Post-spill and treatment, negative responses were observed on communities treated with the SCA, in particular for *Chironomidae* in the peat organic substrate, and *Hyalellidae* in the rock-cobble substrate. The observed results will help inform spill response teams and regulators while selecting appropriate remediation methods for spills within the framework of a net environmental benefit analysis. Based on the observed negative effects of the SCA in the assessed communities we would recommend using this treatment with caution.

Arctic Ecotoxicology: A Critical Review to Break the Ice

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Keywords: Arctic, review, risk assessment

There has been a growing focus to quantify the impact of anthropogenic activities on Arctic ecosystems; however, most regulatory guidelines and risk assessments are built primarily around temperate species. This may result in an underestimation of harm to Arctic organisms. To help address this concern, a critical review to assess reported effects for these species in relation to current regulatory guidelines, quantify knowledge and methodological gaps, and identify future research needs for laboratory testing was performed. To accomplish this, an objective evaluation of the literature was employed to quantify the strengths and relevance of published studies to determine the utility of the data. We developed uniform criteria to score each study, allowing an objective comparison across experiments. Data from all publicly available toxicity tests performed on aquatic Arctic algae (n = 22 distinct experiments), invertebrates (n = 167), vertebrates (n = 149) and microbial consortiums (n = 1) were included. These data encompassed a total of 44 published studies, 48 tested compounds, and 74 unique Arctic test species. Our preliminary analysis shows that of 339 test substance and species combinations scored, 273 (81%) failed to meet at least one critical study criterion that contributes to data reliability for use in risk assessment. Future Arctic ecotoxicology research should work to ensure test concentrations can be analytically confirmed, include environmentally realistic exposure scenarios, and report test methods more thoroughly. By working to address these identified gaps, future ecotoxicological risk assessments for Arctic regions should be more robust and effective.

Effects of Cyprosulfamide on Growth and Reproduction of *Daphnia magna*

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ABSTRACT

Safeners are a group of chemicals applied concurrently to protect crops from potential adverse effects of agricultural products used to kill weeds in monocotyledonous and some dicotyledonous crops. These chemicals are classified as inert for regulatory purposes, but some common ones like dichloroacetamides, have been tested for potential effects on living non-target organisms. The effect of cyprosulfamide, a sulfonamide safener, on the growth and reproduction of freshwater invertebrate (*D. magna*) were examined because daphnids form an important part of the aquatic community. This chronic study was designed using two concentrations (10mg/l and 120mg/l) and a control and lasted for 21days. 10 true replicates were treated with each concentration and control. Body length of the daphnids was recorded every two days and the number of neonates was recorded. Results revealed that cyprosulfamide affected growth and reproduction of daphnids at both concentrations compared to the control group. Retarded growth was observed in daphnids cultured in 10 and 120mg/l concentrations though this was more apparent in the 120mg/l concentration while there was a 60% death of daphnids treated with 120mg/l concentration. This study gives information on the potencies of emerging safeners such as cyprosulfamide to *D. magna* and could be used to infer effects on agricultural systems and in higher animals.

Keywords: Daphnia magna; Growth; Reproduction; Safeners

$_1$H NMR based metabolomic profiling of early life stage zebrafish (*Danio rerio*) exposed to weathered sediment-bound diluted bitumen

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Keywords: PAHs, oil sands, embryotoxicity, dilbit.

Spills of diluted bitumen (dilbit) pose a great risk to the environmental well-being of aquatic ecosystems and with expected increases in production and transportation of dilbit, these risks are expected to increase. While our understanding of the effects of dilbit are increasing, little research has been performed investigating the effects of weathered sediment-bound dilbit (WSD). Therefore, studies have now started to assess these effects in early life stages of fish; however, understanding of the underlying mechanisms of toxicity is still limited. This study used $_1$H NMR based metabolomics, to identify altered metabolites and pathways to provide insight into the underlying mechanisms of toxicity of WSD, in zebrafish (*Danio rerio*). Zebrafish exposed to WSD exhibited an increased prevalence of pericardial edema, yolk sac edema, and swim bladder malformations that are typical of exposure to dilbit. The concentrations 9 metabolites were identified to be potentially altered after exposure to WSD and pathway analysis revealed 4 potentially impacted pathways: 1) phenylalanine, tyrosine, and tryptophan biosynthesis, 2) taurine and hypotaurine metabolism, 3) alanine, aspartate, and glutamate metabolism, and 4) glycine, serine, and threonine metabolism. Altered metabolites and perturbed pathways have been linked to important biological roles and could help to understand the underlying mechanisms of toxicity induced by WSD. Future studies should investigate the role these metabolites and pathways might play in toxicity.

Effects of legacy-contaminated groundwater on swimming behavior of fathead minnow larvae

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Key words: total distance moved, groundwater mixtures, fish

Legacy contamination at industrial sites can lead to the presence of persistent parent molecules, metabolites, and by-products in groundwater. These groundwaters can pose a significant risk to surrounding surface waters threatening aquatic wildlife including fish. Fish behaviour is emerging as a viable endpoint to assess toxicity of chemicals and environmental mixtures. The objective of this study was to assess the effect of groundwater from a legacy contaminated pesticide manufacturing site containing complex mixtures of chemicals on the swimming behaviour of fathead minnow larvae. For this purpose, a sudden light-dark transition test was conducted after 7 days of exposure of the larvae to graded concentrations of different groundwater samples representing reference, medium and high contamination conditions. The results showed that groundwater significantly increased the total distance moved by larvae under both light and dark phase in a concentration-dependent manner. Under dark phase, a NOEC of 10% of groundwater for both moderate and high conditions were observed. Under light phase, NOECs of 5% and 10% of groundwater for moderate and high conditions, respectively, and a LOEC of 10% of groundwater for moderate condition were observed. The excitation observed after exposure to the contaminated groundwater could be representative of an avoidance response. In order to define the specific mode of toxic actions of the observed impacts on swimming behaviour, future omics analyses will be conducted.

Toxicokinetic modeling of selenium in fathead minnow orally exposed to selenomethionine

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Key Words: Selenium, selenomethionine, toxicokinetic, predictive, fathead minnow

Selenium (Se) is a naturally occurring atomic element and an essential micronutrient for almost all forms of life that also has a very narrow threshold between beneficial and harmful doses. Where anthropogenic activities cause excess Se inundation to aquatic environments, Se oxyanions can bioconcentrate in primary producers that subsequently biotransform Se to organic forms capable of bioaccumulating in higher order consumers. When beneficial exposures are exceeded numerous systemic toxicities can manifest in exposed animals, with developmental toxicities in oviparous animals being of primary regulatory concern. Regulatory agencies have therefore set aqueous and/or tissue (muscle, gonad/egg, or whole-body)-based concentration threshold guidelines meant to protect potentially affected environments and animals. The purpose of the present research is to enhance these protections by predicting tissue concentrations of concern in exposed fish before they occur. Toxicokinetic rate constants of Se flux between tissues of SeMet exposed fathead minnow have been derived from literature values and used to inform a compartmental model that is currently capable of predicting muscle, gonad, and whole-body Se concentrations in female fatheads experimentally exposed to SeMet spiked feed, with the model currently showing, on average, 89, 118, and 94% prediction fidelity over time in each respective compartment. These results indicate that Se concentrations in tissues of concern are possible to predict using compartmental toxicokinetic modeling, and that these models may therefore provide an additional means of protection against environmental Se toxicity.

In vitro-in vivo, cross-life stage and inter-species extrapolation of uptake and biotransformation of benzo[*a*]pyrene in two fish species

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Keywords: benzo[*a*]pyrene; biotransformation; *in vitro-in vivo* extrapolation, TK model

Understanding internal dose metrics is integral to adequately assess the impacts environmental contaminants may have on aquatic wildlife, including fish. *In silico* toxicokinetic (TK) models are a leading approach in quantifying internal exposure metrics for fishes; however, they often do not adequately consider chemicals that are actively biotransformed and have not been validated against early-life stages (ELS) that are often considered the most sensitive to the exposure with contaminants. To address these uncertainties, TK models were parameterized for the rapidly biotransformed chemical benzo[*a*]pyrene (B[*a*]P) in embryo-larval and adult life stages of fathead minnows (*Pimephales promelas*) and white sturgeon (*Acipenser transmontanus*). Biotransformation of B[*a*]P was determined through measurements of *in vitro* clearance. Using *in vitro-in vivo* extrapolation, *in vitro* clearance was integrated into a multi-compartment TK model for adult fish and a one-compartment model for ELS. Model predictions were validated using measurements of B[*a*]P metabolites from *in vivo* exposures to graded concentrations of water-borne B[*a*]P. Significant increases in the abundance of B[*a*]P metabolites were observed with exposure to increasing parent compound concentrations. However, there were no differences in phase I or phase II biotransformation with increasing B[*a*]P exposure. Modelling results for fathead minnow show that biotransformation of B[*a*]P can be successfully implemented into *in silico* models to accurately predict the life stage-specific abundances of B[*a*]P metabolites. Parameterization of white sturgeon models are currently ongoing. Our models increase the scope of applications in which TK models can be used in support of environmental risk assessments.

Effects of triclosan on zebrafish embryos and larvae

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Emerging contaminants (EC) are a group of chemicals about which little is known about their effects on biota. Consequently, there is a paucity of legislation regulating the release of these compounds to the environment. Triclosan is such an EC. This compound is an antibacterial agent present in several personal care products. Considering that triclosan occurs in products that are frequently used by the population, this substance is ubiquitously found in water bodies. This study aims to investigate the effects of triclosan exposure on zebrafish embryos (24 hpf) and larvae (96 hpf) development and behaviour. We conducted a rangefinder exposure for triclosan using 0, 0.1, 0.2, 0.5, 1, and 2 mg/L. A flow-through system was used for the contaminant exposure, which renews the exposure solution continuously, since triclosan has a short half-life in solution. We observed a reduction in embryos activity at the highest concentration tested (2 mg/L). Larvae (96 hpf) exposed to 1 or 2 mg/L had a mortality rate of 100%, larvae exposed to 0.5 mg/L were observed to have malformations such as curved spine and pericardial edema. Thus, developmental malformations and behavioural deficits reduce larval fitness. We intend to investigate aspects related to olfactory and visual impairment.

Key Words: activity, emerging contaminant, malformation, behaviour, development

Toxicity assessment and recovery of four hydraulically fractured wells in the Duvernay region

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hydraulic fracturing, flowback and produced waters, *daphnia magna*, toxicity

Hydraulic fracturing (HF) for oil and gas extraction is a widespread practice in Western Canada. HF uses large volumes of water and chemical additives under high pressures to fracture geological formations of low permeability. During this time injected water "flows back" to the surface, with the original injection chemicals and newly formed geogenic chemicals, termed flowback and produced waters (FPW). FPW toxicity is characterized by the geological characteristics of the formation, injection fluid, and shut-in period. Currently wells are individually assessed, despite being on the same geological formation. This project aimed to determine whether toxicity was similar between wells on the same geologic formation at the same spatial time point and using the same injection fluid. We performed an acute (48h) LC_{50}, 21 day chronic, and a 48-hour exposure to 19 day recovery experiment on keystone species, *Daphnia magna*, using the most toxic well out of 4 wells (O, P, U, V) which originated from the same well pad. The 21-day chronic experiment showed well O was the most toxic. Molting and reproduction decreased after acute exposure to 0.75% FPW O, showing results similar to the 21 day chronic experiment, demonstrating that recovery is not possible in the first generation exposed to FPW.

A Novel Multi-Species Physiologically-Based Toxicokinetic Modelling Approach in Support of Chemicals Risk Assessment

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Keywords: PBTK model, multi-species approach, freshwater fish

Contemporary PBTK models for the prediction of bioaccumulation potential of chemicals in fish are based on single-species approaches. These approaches fail to include naturally occurring physiological variability between different species and among individuals of the same species. To overcome this limitation a novel multi-species approach is introduced in this study. By including inter- and intra-species variability of model input parameters through (i) the available physiological data of nonmodel species, and (ii) the incorporation of these data and their statistical distributions rather than as single values, this study developed a new and powerful multi-species PBTK modelling approach.

In an extensive literature search, 2,815 single values were revealed, representing 71.9 % of families of freshwater fishes occurring in Canada. Model validation showed that bioaccumulation potential of 82 % of the modeled neutral organic chemicals were predicted within a 10-fold change respective to the corresponding measured data from the literature. This is in reasonable agreement with previously published single-species models while at the same time significantly improving the level of species diversity. As such, this model will potentially enable more environmentally relevant predictions using already existing data and could ultimately lead toward more sustainable use of existing data for risk assessment of chemicals.

Sunburn Stings: Photo-enhanced toxicity of *Hyalella azteca* exposed to diluted bitumen.

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Key Words: Dilbit, UV, Oil, Phototoxicity

Diluted bitumen, the major product of the oil sands region, is a combination of bitumen and natural gas condensates and synthetic crudes that are added to reduce viscosity so that the product can be transported in pipelines. The rate of diluted bitumen spills has declined over the past decade, but the risk of spills into aquatic environments is still a concern. Previous studies have evaluated the toxicity of diluted bitumen, but many overlook the potential for photo-enhanced toxicity of oil constituents in environments with UV exposure. To examine the interactive effects of diluted bitumen and UV radiation, *Hyalella azteca* were exposed to three water accommodated fractions of diluted bitumen, under low (10%) and high (90%) UV exposure. When exposed to diluted bitumen and UV radiation in combination, *Hyalella azteca* had significantly increased mortality and deformities, and reduced growth suggesting that the potential for photo-enhanced toxicity should be considered when examining the potential effects of diluted bitumen spills in freshwater environments.

Chronic toxicity of waterborne thallium to *Daphnia magna*

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Key words: Thallium, *Daphnia*, toxicity, bioaccumulation

Thallium (Tl), is a trace metal commonly enriched as a byproduct of other anthropogenic processes such as mining and smelting of base metals, production of cement, and the mining and burning of coal. While limited information relative to Tl toxicity to aquatic biota exists, the majority is acute in nature. The presented work identifies the effects of waterborne Tl on chronic toxicity endpoints (final body weight as a proxy measure of growth, survival, and reproduction) and body burden to water flea (*Daphnia magna).* Following 21-d exposure, median effective concentrations for final body weight and reproduction were 1.6 and 11.4 µg Tl L^{-1}, respectively. Tl body burden was significantly different from control daphnids at elevated concentrations (428 4 µg Tl L^{-1}). In contrary to previously published work, Tl related toxic effects were not related to changes in whole body potassium concentration. Thus, suggesting different toxic mechanisms exist between studied freshwater aquatic species and length of exposure. With no observed adverse effects occurring at Canadian Council of Ministries of the Environment water quality guidelines (0.8 µg L^{-1}), current regulations are likely protective against chronic toxicity to *Daphnia magna*.

Mechanism of copper nanoparticle toxicity in rainbow trout olfactory sensory neurons

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Keywords: Copper nanoparticles, Olfactory toxicity, Rainbow trout.

The objective of this study was to investigate the mechanism of copper nanoparticles (CuNPs) induced olfactory toxicity in rainbow trout. Fish were exposed to the 50% inhibitory concentration of CuNPs (24 h IC50: 322 µg/L of CuNPs) for 96 h. RNA-Sequencing transcriptional analyses revealed that all key pathways of olfactory sensory neuron (OSN) function, including odorant signal reception (i.e. olfactory signal transduction (OST) cascade), action potential generation, and synaptic transmission, were strongly affected by CuNPs. The significant transcriptional downregulation of many olfactory receptors and ion channels/transporters involved in the OST cascade elucidated OST dysfunction. Nevertheless, the expression of key genes involved in action potential generation were all upregulated. The strengthened generation of action potential can compensate for the weakened membrane receptor potential from the OST cascade. Despite the upregulation of genes associated with the production of action potentials in CuNP-exposed OSNs, the propagated action potential could not be efficiently transmitted to mitral cells to be ultimately perceived by brain. Synaptic vesicular cycling, which regulates neurotransmitters released from the axon terminal, was impaired by CuNPs. The impaired OST pathway along with reduced synaptic transmission can explain the olfactory dysfunction induced by CuNPs.

Keywords: Copper nanoparticles, Olfactory toxicity, Rainbow trout.

Impact of secondary oil remediation methods for diluted bitumen on freshwater plankton and algae in a boreal lake

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Key words: Oil, Algae, Freshwater

The Freshwater Oil Spill Remediation Study (FOReST) evaluated the effectiveness of clean-up methods following diluted bitumen spilled into 10 m x 5 m enclosures in the littoral zone of a boreal lake. Remediation included industry standard primary clean up using sorbent pads to recover oil from the water surface, and secondary clean up using either enhanced Monitored Natural Recovery (nutrient additions to stimulate bacterial and algal communities) or the shoreline cleaner Corexit® EC9580A. We characterized the response level of lower trophic level communities, specifically phytoplankton and periphyton over 80 days in a wetland habitat and a rock-cobble habitat. Linear mixed modeling found a significant difference ($p<0.05$) from control within both phytoplankton chlorophyll-a and periphyton chlorophyll-a biomass in the wetland substrate, and no significant difference in the rock-cobble substrate. The physiological response of the phytoplankton community was assessed using Pulse Amplitude Modulated (PAM) fluorometry with no significant effects observed for any treatment from controls. We conclude that the addition and remediation of diluted bitumen led to significant effects on both phytoplankton and periphyton biomass, but no effects on the physiology of photosynthesis were detected.

Preliminary Results of Rainbow Trout Exposure to Platinum Group Elements

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animal behaviour, bioaccumulation, olfaction, platinum group elements

Platinum group elements (PGEs) are used in various industrial applications due to their physical and chemical properties, yet few ecotoxicological studies have focused on these metals. Primarily used as the main component for auto-catalysts, but also widely used in other applications, platinum (Pt) and palladium (Pd) can be introduced to aquatic habitats where they can accumulate within aquatic ecosystems due to automotive emissions. Despite the widespread use of PGEs, there are limited data on ecological risk assessment as well as the uptake and toxicity of PGEs to aquatic species. In the present study, tissue-specific bioaccumulation and chemosensory inhibition within juvenile rainbow trout were explored after a 96-hour exposure to Pt or Pd. Exposure concentrations ranged from 0 μg/L – 72.9 μg/L and 0 μg/L – 500 μg/L for Pd and Pt, respectively. Results from this study showed that within these ranges, olfactory acuity was impaired. Additionally, exposure to Pd resulted in higher olfactory toxicity than Pt when measured using an electro-olfactogram. Metal accumulation within specific tissues was also investigated to contribute knowledge about these data-poor metals and to help define the direction of future studies. Preliminary testing has demonstrated that PGEs cause sublethal impairment in fish after acute aqueous exposure. Future studies will continue to expand the investigation on PGEs and their effects on fish behaviour, olfaction, and bioaccumulation.

Detection of hormones and growth promotors in soil from fields under different manure application methods

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Cattle manure application to agricultural fields is a common manure management strategy with the potential to facilitate manure-borne steroid hormone transport and release into ecosystems. Identifying manure management practices that contribute less hormones to ecosystems is essential to minimize environmental impacts. Therefore, this research aims to determine whether conventional (constant) and precision (variable) rate manure-amended soils differ in hormone-active compound occurrence and levels. Chemical analysis was used to assess hormone concentrations in beef cattle manure from windrow piles, and soil from nine watershed basins within three field application zones: commercial fertilizer (control), constant manure rate, and variable manure rate. Analytes targeted in manure and post-manure application soil samples, collected in May and August of 2019, respectively, included natural and synthetic hormones, their metabolites, and a β-adrenergic agonist: estrone, trenbolone acetate, melengestrol acetate, 17α-trenbolone, 17β-trenbolone, trendione, melengestrol, and ractopamine. Except for ractopamine in all soil samples, no measurable analyte levels were detected in any samples. Soil ractopamine levels were very low, ranging from 0.021 – 0.354 ng/g; this detection is surprising, since cattle, from which manure originated, received no ractopamine. Since hormones are often active at levels below chemical detection limits, future work will assign and identify estrogenic and androgenic activities and concentration equivalents to manure, soil, and basin surface runoff water using reporter gene bioassays.

The novel brominated flame retardant, 1,2,5,6-tetrabromocyclooctane (TBCO), impairs oocyte maturation in zebrafish (*Danio rerio*)

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Keywords: reproduction, oocyte maturation, micro RNA

The novel BFR 1,2,5,6-Tetrabromocyclooctane (TBCO) is an endocrine-disrupting chemical that decreases fecundity of Japanese medaka (*Oryzias lapites*). It has been proposed that this might be due to impairment of oocyte meiosis. However, this mechanism remains uninvestigated. Thus, objectives of this study were to determine if TBCO impairs oocyte maturation and to investigate molecular mechanisms of effects. Sexually mature female zebrafish (*Danio rerio*) were given a diet of 100 (low) or 1000 (high) μg TBCO / g food for 14 days. *In vitro* maturation of stage IV oocytes from fish exposed to TBCO was significantly less than maturation of oocytes from control fish. Among a suite of genes that encode proteins involved in signal transduction and meiotic resumption during oocyte maturation, mRNA abundances of *mPRα* and *igf3* were decreased in oocytes from fish exposed to TBCO suggesting involvement in impairment of oocyte maturation. High-throughput sequencing and functional annotation of small non-coding RNAs identified six and nine differentially expressed miRNAs in oocytes from fish given low or high TBCO, respectively. Several differentially expressed miRNAs are known to regulate processes that control oocyte maturation in mammals. Overall, results indicate that effects of TBCO on fecundity might be due to impairment of oocyte maturation and provide novel information on mechanisms which disrupt oocyte maturation.

Laundry-effluent toxicity of copper-treated textiles to freshwater invertebrates

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The treatment of textiles with metal nanoparticles is an emerging trend owing to the potential antibacterial (treated with silver) or antimicrobial (treated with copper) properties provided by the coatings. While the initial association between nanoparticle and fabric may be strong, it remains largely unknown how laundering the products affects this association. In this study, we obtained athletic socks that had been treated with copper, which we confirmed using graphite furnace atomic absorption spectroscopy (GFAAS). We then performed one of two types of laundering protocols: (1) five cycles of wash-only, or (2) five cycles of washing and drying (with moderate heat). The effluent from each wash cycle was collected and the amount of copper within the effluent was quantified using GFAAS. Nearly double the amount of copper was found in wash-only laundered socks as compared to non-treated textiles, and nearly triple the amount of copper was released from socks that were both washed and dried. Subsequently, two model freshwater invertebrates, *Daphnia magna* and *Hyalella azteca*, were exposed to the effluents for 24 hours. Complete mortality was observed in *D. magna* and differential mortality as well as behavioural changes were observed in *H. azteca* following exposure. The detrimental consequences observed in freshwater species exposed to common household effluents stresses the need to further our understanding of the environmental implications of textile treatment practices.